The Examiner has objected to claims 23 because it depends on a canceled claim. Applicant has amended claim 23 to overcome this objection. Applicant has also amended claim 24 to correct a minor typographical error. These amendments do not narrow the scope of these claims and do not add any new matter. Applicant has added claims 26-29 to better define the invention. Claims 26-29 do not add any new matter.

The Examiner rejects claims 22-25 under 35 USC § 102(b) as being anticipated by U.S. Patent No. 4,659,224 to Monchalin (hereinafter "Monchalin"). Applicant respectfully traverses the Examiner's rejection in view of the following remarks and submits that the claims herein are patentable over the prior art.

The invention results from the realization that a truly elegant yet extremely reliable continuous and high speed detection system for detecting a flaw in a medium such as a conveyor belt, cable, rope, railroad track or road can be effected by sensing a Doppler shift in a carrier signal caused by a flaw.

This invention features a flaw detection system using acoustic Doppler effect for detecting flaws in a medium wherein there is relative motion between the medium and system. There is a transducer or transducer means, spaced from the medium to be inspected, for introducing to and sensing from the medium an acoustic signal that propagates in said medium at a predetermined frequency. There is also a detector or detector means, responsive to the sensed propagating acoustic signal, for detecting in the sensed acoustic signal the Doppler shifted frequency representative of a flaw in the medium.

As noted in the subject application, there are significant advantages from using transducers that sense acoustic signals:

> Air-coupled transducers are attractive because they allow ultrasound

> to propagate through gaseous media without requiring mechanical contact between the transducer and the medium to be inspected. When used for inspecting railroad tracks <u>the acoustic impedance mismatch between the steel and air is used to great advantage since it reflects most of the energy from the steel surface back to the transducer.</u> When the invention is employed in railroad rail monitoring, a typical car speed for monitoring the rail may reach above sixty miles per hour and in fact, increased car speed leads to more pronounced Doppler effects and better overall efficiency.

(Application at p. 10, lines 9-16, *emphasis added*).

Fig. 4 of Monchalin shows a laser system 7 that emits an incident beam 9 of *substantially monochromatic coherent light*. An interferometer 22 measures the Doppler effect *of the scattered light* from the laser system 7. Monchalin does not disclose, however, a transducer or transducer means <u>for sensing from the medium an acoustic signal</u>, nor a detector or detector means, responsive to the sensed propagating acoustic signal, <u>for detecting in the sensed acoustic signal</u> the Doppler shifted frequency representative of a flaw in the medium.

Monchalin describes that it senses light and measures the Doppler effect from light energy:

> The apparatus of the present invention is for *measuring the Doppler shift produced in a beam of coherent light* when the said beam is scattered by a surface portion of a material undergoing deformation responsive to the presence of an ultrasonic wave. The apparatus comprises a laser system for transmitting an incident beam of coherent light and modulation means for modulating the incident beam with a predetermined frequency f_M. ... *An interferometer of the confocal FabryPerot type is disposed in the path of the scattered beam transmitted by the optical assembly means for producing an optical interferometer signal.*

(Monchalin at Col. 3, lines 11-27, *emphasis added*). Monchalin further makes clear that the interferometer 22 measures electromagnetic *light energy*:

> Apertures 26 and 27 [of the Fabry-Perot interferometer 22] limit

> the inclination of the *light rays* to satisfy the proper operating conditions of the interferometer 22. In order to use all the *light energy* provided by the laser system, the illuminated spot size on the surface portion 20 should match exactly aperture 27 and the usable area of the central fringe inside the confocal Fabry-Perot interferometer 22.

(Monchalin at Col. 6, line 5-11).

Moreover, Monchalin does not disclose using acoustic Doppler effect to detect flaws in a medium as does the subject invention. Monchalin discloses:

> [A] non-contact optical technique for measuring small deformations at a surface portion of a material produced by an ultrasonic wave energy. More particularly, it is concerned with an apparatus and a method of measuring the optical Doppler shift produced in a beam of coherent light from a laser when the beam is scattered by the surface portion of the material which is undergoing deformation responsive to the ultrasonic wave energy.

(Monchalin at Col. 1, lines 6-14, *emphasis added*). It is clear from this passage that Monchalin is limited to a method of measuring the optical Doppler effect produced in a beam of coherent light.

In contrast, claim 1 of the subject application recites a flaw detection system using acoustic Doppler effect for detecting flaws in a medium wherein there is relative motion between the medium and system comprising: transducer means, spaced from the medium to be inspected, which transmit optical energy for introducing to and sensing from the medium an acoustic signal that propagates in said medium at a predetermined frequency; and means, responsive to the sensed propagating acoustic signal, for detecting in the sensed acoustic signal the Doppler shifted frequency representative of a flaw in the medium. Monchalin does not disclose nor suggest such an apparatus. Independent claims 24-26 and 28-29 likewise recite similar limitations that clearly distinguish the

subject invention from Monchalin.

In simple terms, Monchalin shows a system that transmits light energy which induces an ultrasonic signal in a medium. Monchalin, however, detects a Doppler shift in *light energy* that has changed due to the induced ultrasonic signal. On the other hand, the subject invention induces an acoustic signal in a medium, but senses *acoustic energy* to determine the Doppler shift. The Examiner should note that acoustic energy relates to audible or inaudible sound, while light energy relates to electromagnetic energy which is different than sound. Some of the benefits of sensing an acoustic signal to determine the Doppler shift are noted in the subject application and restated above.

Accordingly, Monchalin does not disclose nor suggest the subject invention. Applicant respectfully requests that the Examiner withdraw the rejection of claims 22-25 under 35 USC § 102(b).

Each of the Examiner's rejections and objections has been addressed or traversed. Accordingly, it is respectfully submitted that the application is in condition for allowance. Early and favorable action is respectfully requested.

If for any reason this Response is found to be incomplete, or if at any time it appears that a telephone conference with counsel would help advance prosecution, please telephone the undersigned or his associates, collect in Waltham, Massachusetts, (781) 890-5678.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

Please amend claim 23 as follows:

23. (Once Amended) The flaw detection system using acoustic Doppler effect of claim [5] 22 in which said transducer includes a laser for transmitting said optical energy.

Please amend claim 24 as follows:

24. (Once Amended) A flaw detection system using acoustic Doppler effect for detecting flaws in a medium wherein there is relative motion between the medium and system comprising:

transducer means, spaced from the medium to be inspected, for introducing to and sensing from the medium an acoustic signal that propagates in said medium at a predetermined frequency said transducer means including a laser vibrometer interferometer for sensing the acoustic signal propagating in the medium[;].

Please add claims 26-29 as follows:

26. A flaw detection system using acoustic Doppler effect for detecting flaws in a medium wherein there is relative motion between the medium and system comprising:

a transducer, spaced from the medium to be inspected, that transmits optical energy for introducing to and sensing from the medium an acoustic signal that propagates in said medium at a predetermined frequency; and

a detector, responsive to the sensed propagating acoustic signal, that detects in the sensed acoustic signal the Doppler shifted frequency representative of a

flaw in the medium.

27. The flaw detection system using acoustic Doppler effect of claim 26 in which said transducer includes a laser that transmits said optical energy.

28. A flaw detection system using acoustic Doppler effect for detecting flaws in a medium wherein there is relative motion between the medium and system, comprising:

a transducer, spaced from the medium to be inspected, that introduces to and senses from the medium an acoustic signal that propagates in said medium at a predetermined frequency, said transducer including a laser vibrometer interferometer that senses the acoustic signal propagating in the medium.

29. A flaw detection system using acoustic Doppler effect for detecting flaws in a medium wherein there is relative motion between the medium and system, comprising:

a transducer, spaced from the medium to be inspected, that induces an acoustic signal to propagate in the medium at a predetermined frequency and senses the propagating acoustic signal in the medium, said transducer including a transmitter and a receiver, said transmitter including a laser that locally heats the medium to generate acoustic signals; and

means, responsive to the sensed propagating acoustic signal, for distinguishing the Doppler shifted frequency representative of a flaw in the medium.